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# B112 Data Center

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Data Center Dynamics  
San Francisco, CA, United States  
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## B112 Data Center

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Lawrence Livermore National Laboratory  
Data Center Remodel Project

Presented by: Curt Tom – LLNL / ICS  
Ron Hughes – CDCDG



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# A Team Effort

- LLNL Staff
- California Data Center Design Group
- HWA/APC
- Ken Nix and Associates
- Apparatus Testing and Engineering
- Nova Partners





## How the project started

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- CDCDG was contracted by LLNL/ICS to conduct an engineering evaluation of LLNL's current data center
- Results of the evaluation showed that the current data center was inadequate
- CDCDG/LLNL reviewed alternative sites and identified an existing data center that could be retrofit
- CDCDG worked with LLNL to identify their long term requirements and design goals



# The Process

- CDCDG worked with LLNL to prepare a list of site upgrades to meet their long term requirements
- Prepared a budget and sought approval
- LLNL received funding and proceeded with a turnkey contract that was awarded to APC
- Retrofitted LLNL Bldg. 112 Data Center
- Tested and commissioned the site



# Design Goals

- Design Goals
  - Highly reliable
  - Energy efficient
  - Modular and Scalable
  - Designed for 75 watts per square foot expandable to 150
  - Tier 3 Plus
  - Limited budget



# Long term requirements

- Scalable data center that can grow as LLNL needs grow
- Flexible infrastructure to support higher density solutions
- 2 Utility feeds, but no generator backup





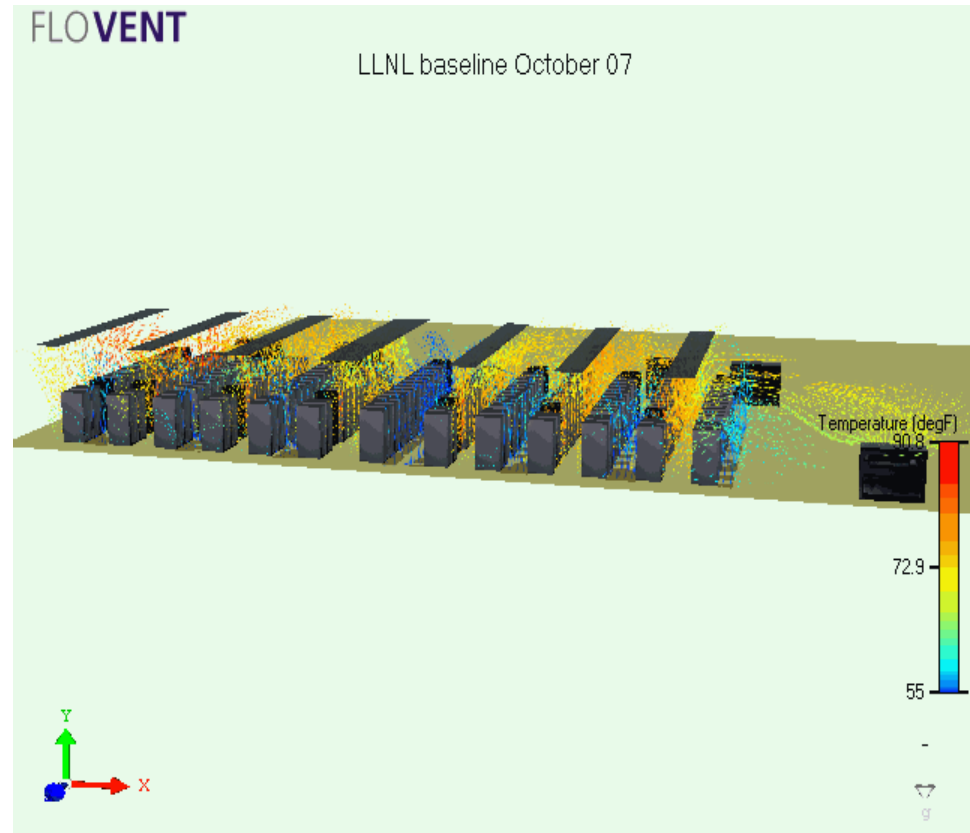
# Design Solutions

- 2N electrical design
- Scalable APC 1,000 kW UPS modules
- N+1 Mechanical Systems
- 2 new 450 Ton chillers
- 2 utility feeds from 2 separate utilities



# Green data center highlights

- Use of scalable, highly efficient UPS systems
- 2N electrical design
- Ducted CRAC unit returns
- 2 utility feeds from different utilities
- No diesel generators
- Fully tested and commissioned



# Construction challenges

- Both utility feeds needed to be upgraded
- All new utility switchgear
- Intensive safety and security requirements
- Building shutdowns required for drilling into slab
- Coordination of shipments through security



# Testing and Commissioning

- All systems fully tested and commissioned
- Electrical testing by ATE
- Startups completed by manufacturers
- Substation ATS's tested with load
- All systems tested to 100% of capacity
- Integrated systems test with load





# Final Results



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# Central Elevation View



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# Network Distribution Row



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## B112 Data Center

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Where we are and how we  
got here...



Information & Communication Services

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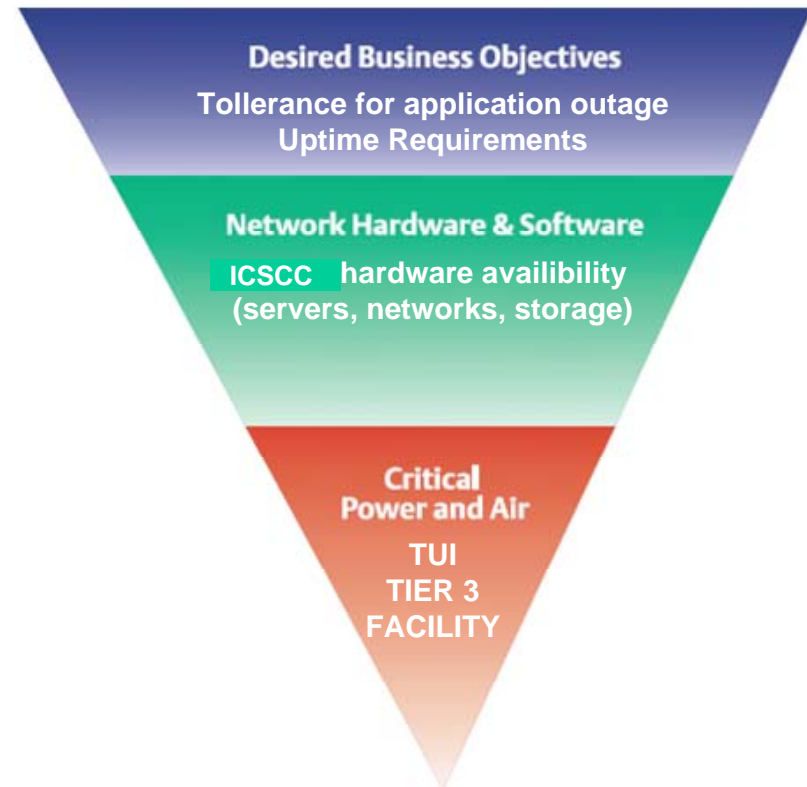
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# ICS operational goals – high availability

## Application and Web Hosting services

- This model depicts how critical the facility is in support of the IT environments which host IT applications which service the LLNL community
- The desired business requirements are at the top of the pyramid, the IT layer is in the middle and the critical support infrastructure is at the bottom
- The pyramid is inverted because the investment is smallest at the bottom of the model and largest at the top



*\* Model from TUI / Intel Corp. / Liebert Corp.*



# Previous Data Center

- **Age and structure**
  - 1987 construction, 21 years old
  - 13 trailers bolted together
  - Temporary structure - blueprints limited or unavailable
  - Soil foundation on wood braces (seismic bracing of equipment limited)
  - Metal roof with known leaking problems
  - Fire code sprinkler standards compromised due to ceiling height
  - 21 year old computer room air conditioners – need to be replaced
  - Limited electrical capacity



# Previous Data Center – per CIO, “a data center on life support”

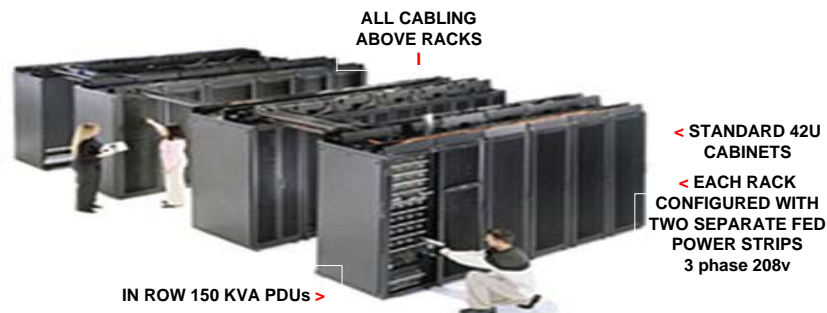
- **Significant cooling and power limitations**
  - Limited 8' ceiling height and 10" subfloor
  - Miles of network/power cables in subfloor
  - Chilled water, Halon and CO2 pipes
  - Limited electrical capacity
- **Added temporary fixes**
  - 2 portable A/C units and portable substation





## Search for replacement Data Center

- Contracted with California Data Center Design Group (CDCDG)
- LLNL Red Team formed to look at alternatives and costs
- Utilized Uptime Institute's tiered data center model
- Requirements based on best practices
- Evaluated Lab sites and facilities

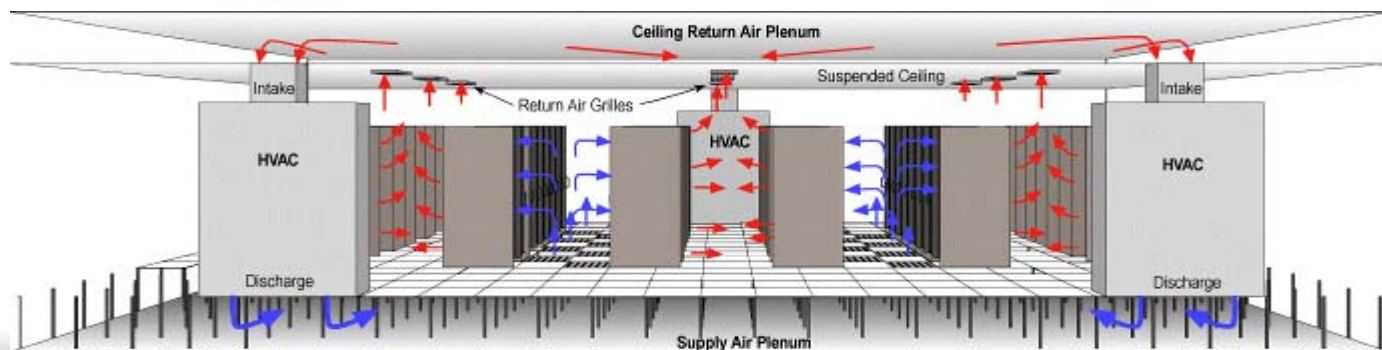


This chart illustrates Tier similarities and differences

	TIER I	TIER II	TIER III	TIER IV
Number of delivery paths	Only 1	Only 1	1 active 1 passive	2 active
Redundant components	N	N+1	N+1	2 (N+1) or S+S
Support space to raised floor ratio	20%	30%	80-90%	100%
Initial watts/ft <sup>2</sup>	20-30	40-50	40-60	50-80
Ultimate watts/ft <sup>2</sup>	20-30	40-50	100-150	150+
Raised floor height	12"	18"	30-36"	30-36"
Floor loading pounds/ft <sup>2</sup>	85	100	150	150+
Utility voltage	208, 480	208, 480	12-15kV	12-15kV
Months to implement	3	3 to 6	15 to 20	15 to 20
Year first deployed	1965	1970	1985	1995
Construction \$/ft <sup>2</sup> raised floor*	\$450	\$600	\$900	\$1,100+
Annual IT downtime due to site	28.8 hrs	22.0 hrs	1.6 hrs	0.4 hrs
Site availability	99.671%	99.749%	99.982%	99.995%

\*Excludes land and abnormal civil costs. Assumes minimum of 15,000 ft<sup>2</sup> of raised floor, architecturally plain one story building, fitted out with initial capacity, but with a backbone designed to reach the ultimate capacity with the installation of additional components. Make adjustments for NYC, Chicago, and other high cost areas.

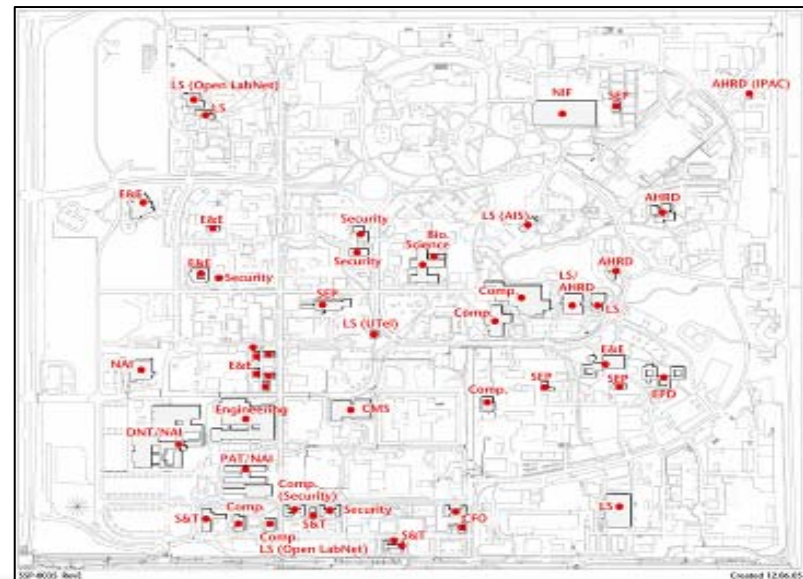
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B112 selected as a means to consolidate various data centers across the Lab and reduce costs

- **Goal - deliver a professionally run, highly available unclassified 7x24 data center:**
  - Standards based to provision secure, stable and supportable environments
  - Restricted access to center with remote capabilities
  - Estimated computer equipment value at full capacity ~ \$40M
- **B112 required significant work**



# Projects launched aimed at meeting the Uptime Institute's Tier 3 Data Center model

The preliminary plan included all of ICS's technical requirements		
Requirement	Preliminary Plan	Current Plan
Computer equipment load of 150 watts/sf	Provided by a separate substation	Provided by a separate substation
Building cooling to meet the power requirement	Provided by installing sufficient new equipment	Provided by installing sufficient new equipment
Redundant/standby power	Provided by double ended substation design with each transformer loaded at 50%	Provided by double ended substation design with each transformer loaded at 50%
N+1 chillers	Buy enough equipment	Buy enough equipment
N+1 CRAC units on main floor	Buy enough equipment	Buy enough equipment
N+1 CRAC units in UPS room	Buy enough equipment	Buy enough equipment
Backup to site wide LCW plant	Provide air cooled chiller plant to supply chilled water	Not provided
Replace first floor computer floor	Provide new floor	Provide new floor
GPP funding limit of \$5.0M	Over \$5.0M	Under \$5.0M
Preliminary plan was not entirely achievable due to the building equipment substation's 2,000 amp capacity. Air cooled chillers required too many amps.		



Project started 10/16/06 with demolition – first visible sign of change was the new building number: B112

18" raised floor



Rooms in the center

Asbestos abatement in  
the new UPS room  
and demolition of  
basement rooms





# New 30" height computer room floor installed

- Live conduit found in concrete slab dictated more costly safety procedures
- Upgraded stanchions and floor tiles installed
- New fire suppression Inergen system expanded to cover prior space occupied by center offices
- New ramps installed to enable access to original floor





## Cooling infrastructure expanded to meet new computer loads and readied for modular expansion as needed

- **Water pipes installed in center of data center readied for non-invasive incremental air conditioner hookups (when needed)**
- **More chilled water fed to B112 and 2 new chillers and pumps added**
- **New air conditioners installed in UPS rooms and data center (N+1)**
- **Mechanical substation reconfigured to be fed by two independent electrical feeds**



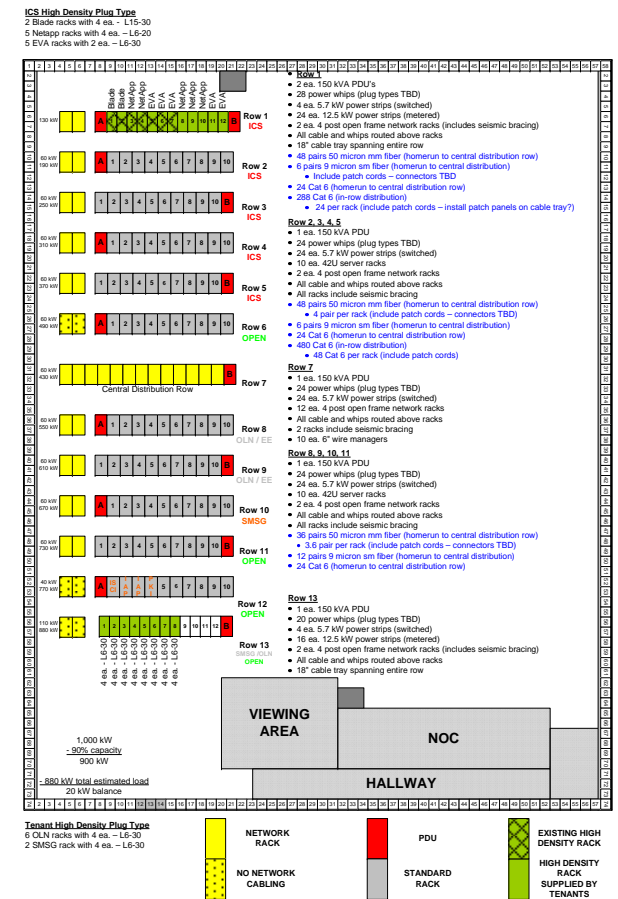
# Electrical infrastructure expanded to meet new computer loads with 2N design

- Unused substation refurbished and augmented with a 2N design and an automatic transfer switch (2.5 MW for computer equipment )
- Again, substation is fed from 2 independent Lab feeders to B112/B113
- UPS and battery rooms constructed and 2 new UPS's and batteries installed (1 MW each for failover)
- PDU's, large conduits and miles of power cables installed (again 2N design)



# Rack infrastructure installed

- 100 servers racks and 36 network racks installed
- Overhead trays installed for cable plant
- Complete electrical and mechanical load tests conducted including upstream failover



**Tenant High Density Plus Type**  
 6 OLN racks with 4 ea. - L6-30  
 2 SMSG rack with 4 ea. - L6-30



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# Metrics – logistics and coordination nightmare!

- 19 subcontractor organizations were used
- 163 subcontractors worked on the projects
- 160 truck deliveries from B411 to B112
- 512 UPS batteries installed & tested
- 16,000' of high voltage cables were installed
- 15,000' of testing cables were used for the load bank data center commissioning tests
- 272 rack PDU's configured and tested
- 16,500 sq. ft. of new raised floor tile installed
- 4,125 tiles installed
- 8, 250 stanchions installed
- 33,000 holes to drill under new safety rules
- 7 weekend facilities outages were needed for drilling



# Next step – Data Center Relocation project!

